ENERGY ENGINEERING ANALYSIS PROGRAM

FORT DRUM, NEW YORK

"CORRECTED"

EXECUTIVE SUMMARY
FINAL REPORT
INCREMENTS A, B, C, D, & G

DECEMBER, 1981

PREPARED FOR
NORFOLK DISTRICT
U.S. ARMY CORPS OF ENGINEERS
NORFOLK, VIRGINIA
CONTRACT NO. DACA65-C-0013

PREPARED BY
BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

DEPARTMENT OF THE ARMY
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EXECUTIVE SUMMARY

A. FINDINGS.

1. Insulation and other weatherization measures represent the most significant opportunities for reduction in energy consumption.

2. The most cost effective energy conservation project found within the scope of this study is automatic setback of building heating systems during unoccupied periods. The most suitable means of accomplishing this is to use a central processor and FM radio signals. Such an FM control system can economically be used to control peak electrical demands by load shedding electric heat and water well pumps.

3. Circular fluorescent lighting systems have been found to be cost effective in selected buildings at Fort Drum.

4. Wind turbine-generated electrical power is expected to be cost effective for Fort Drum by 1985 if projected trends in wind turbine cost and electrical energy cost are realized.

5. The concept of converting solid waste to energy at Fort Drum is not cost effective due to a widely fluctuating population.

6. Total energy and selective energy have both been found to be less cost effective than a central wood-fired water boiler plant.

7. Solar energy is not cost effective for Fort Drum.

8. Under Facilities Engineering Analysis Program, Vol. II B, 29 projects were identified that were less than 100,000 dollars and therefore did not meet ECIP criteria.

9. EMCS was evaluated in accordance with TM-5-185-2 and was rejected in favor of FM control.

10. Duty cycling of fans was rejected because there are very few large fans.

B. RECOMMENDATIONS.

1. It is recommended that weatherization ECIP projects, T-072, T-073, and T-097, be implemented. Project Development Brochures, 1391's, and backup data are included in Volume III.

2. It is recommended that ECIP project, T-096, FM Control System, be implemented in FY 1984. Project Development Brochures, 1391's, and backup data are included in Volume III.

3. It is recommended that a central wood-fired hot water boiler plant be installed in the permanently occupied area of Fort Drum.

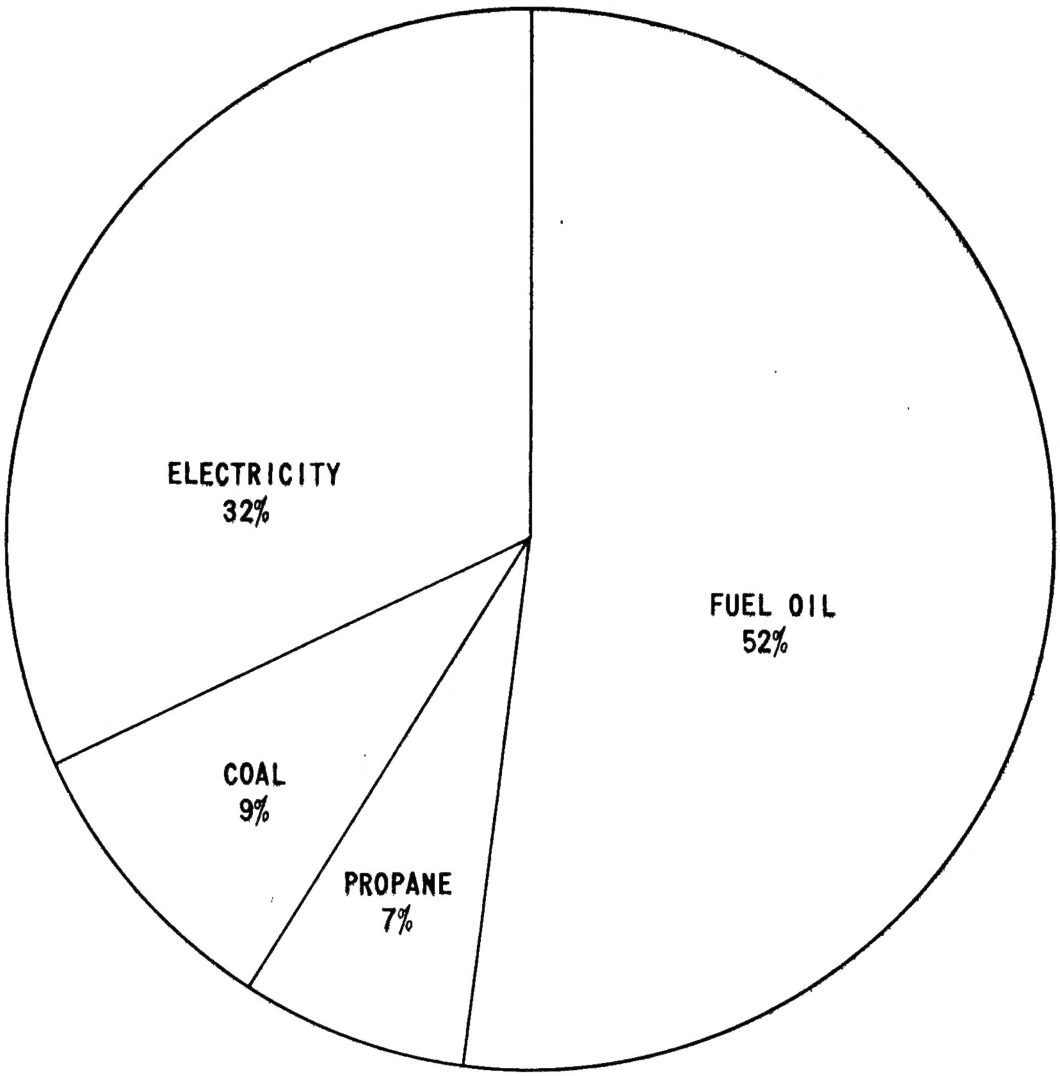
4. It is recommended that wind turbine generated electrical power be reevaluated in 1985.

5. It is recommended that the 26 projects identified in Facilities Engineering Conservation Measures, VOL. IIB, with paybacks less than 15 years and E/C ratio greater than 1 be implemented.

C. SUMMARY. Included in this summary are the results of the Energy Engineering Analysis Program for Fort Drum, New York. This plan included an analysis and recommendation of energy conservation projects for the reduction of the installation's present energy consumption. Black & Veatch has developed projects that meet the funding criteria of the Energy Conservation Investment Program. In addition, a number of energy conservation methods were analyzed which, due to specific factors unique to Fort Drum, do not presently meet funding criteria. Results of these analyses, projections of future energy consumption, and estimated break downs of present energy consumption are presented in this summary.

Energy is projected to cost $2,770,000 per year by FY 1982 at Fort Drum. As shown in Figure 1, fuel oil is expected to represent 52 percent of the cost, with 32 percent being electricity, 9 percent being coal, and

ENERGY COSTS BY SOURCE
($2,770,000/YEAR)



PROJECTED FOR FY82
BASED ON FY78 CONSUMPTION

FIGURE 1

7 percent being propane. These figures are based on FY 78 consumption and projected FY 82 costs. Energy consumption in even numbered fiscal years runs approximately one-third higher than odd numbered fiscal years due to the Empire Glacier winter training exercises conducted every other January at Fort Drum.

Energy consumption in million Btu's for FY 78 is broken down by fuel type and shown in Figure 2. Electricity represents the largest amount of the energy consumed at Fort Drum with 38 percent. Fuel oil is next with 35 percent, coal with 22 percent, and propane with 5 percent.

Energy conservation projects developed by Black & Veatch for Fort Drum have been grouped into four projects. In addition, a wood-fired central heating plant and distribution system is programmed for Fort Drum. BY FY 1986, when all five of these projects have been implemented, the fuel mix will be dramatically changed. As is shown in Figure 3, electricity will remain essentially unchanged at 39 percent; however, fuel oil consumption will be dramatically reduced to 5 percent, wood will represent 18 percent of the energy consumption, coal will decrease to 14 percent, and propane will remain unchanged at 5 percent. Energy savings will represent 14 percent with an additional 7 percent from Facilities Engineers conservation measures.

Existing energy consumption of the various buildings at Fort Drum has been estimated on the basis of 14 representative building types. Table 1 in Appendix A lists these buildings and provides basic data. Energy consumption varies considerably for the different types of buildings due to the wide variations in occupancy. Some building are occupied

FY78 ENERGY CONSUMPTION BY SOURCE
(545,245 MMBTU)

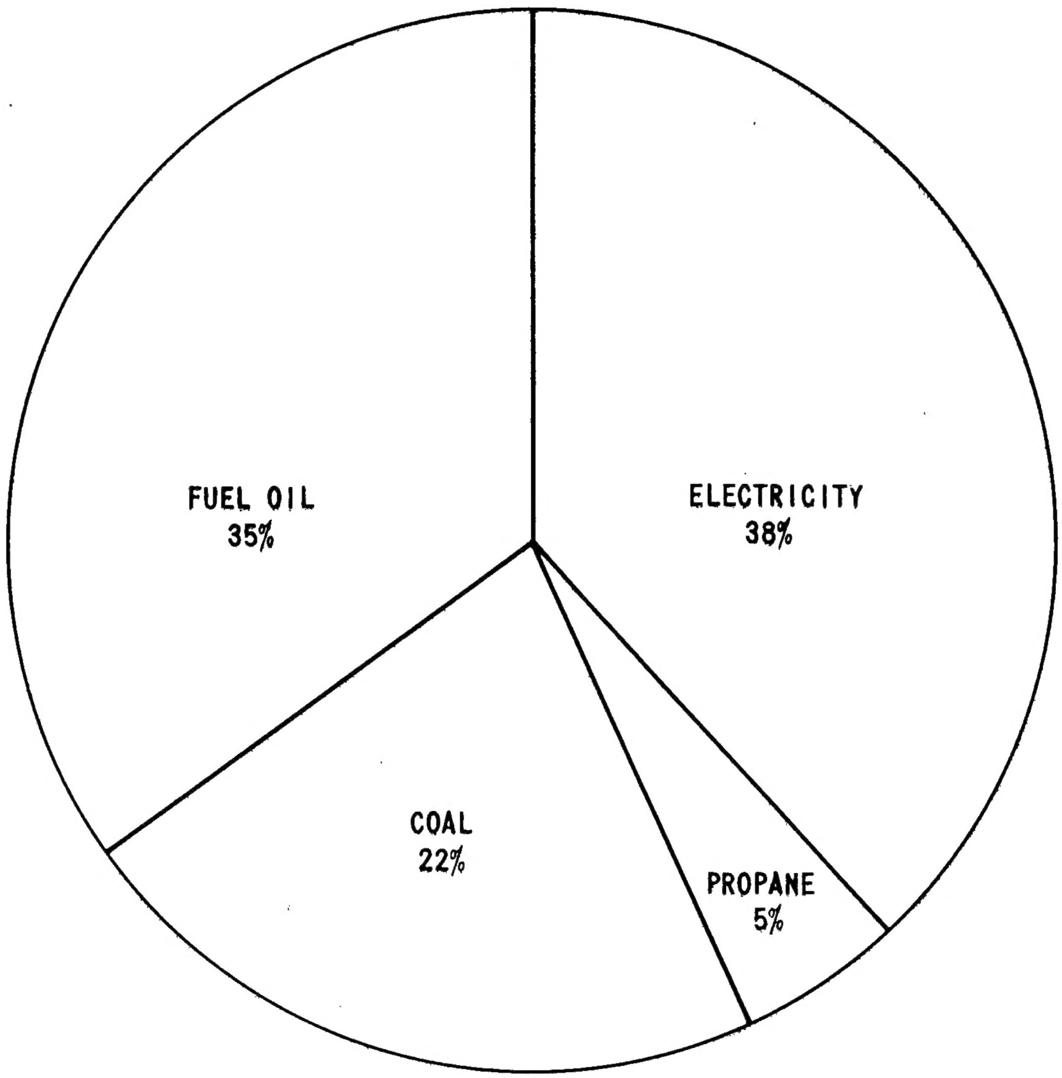


FIGURE 2

PROJECTED ENERGY CONSUMPTION BY SOURCE
(431,536 MMBTU)

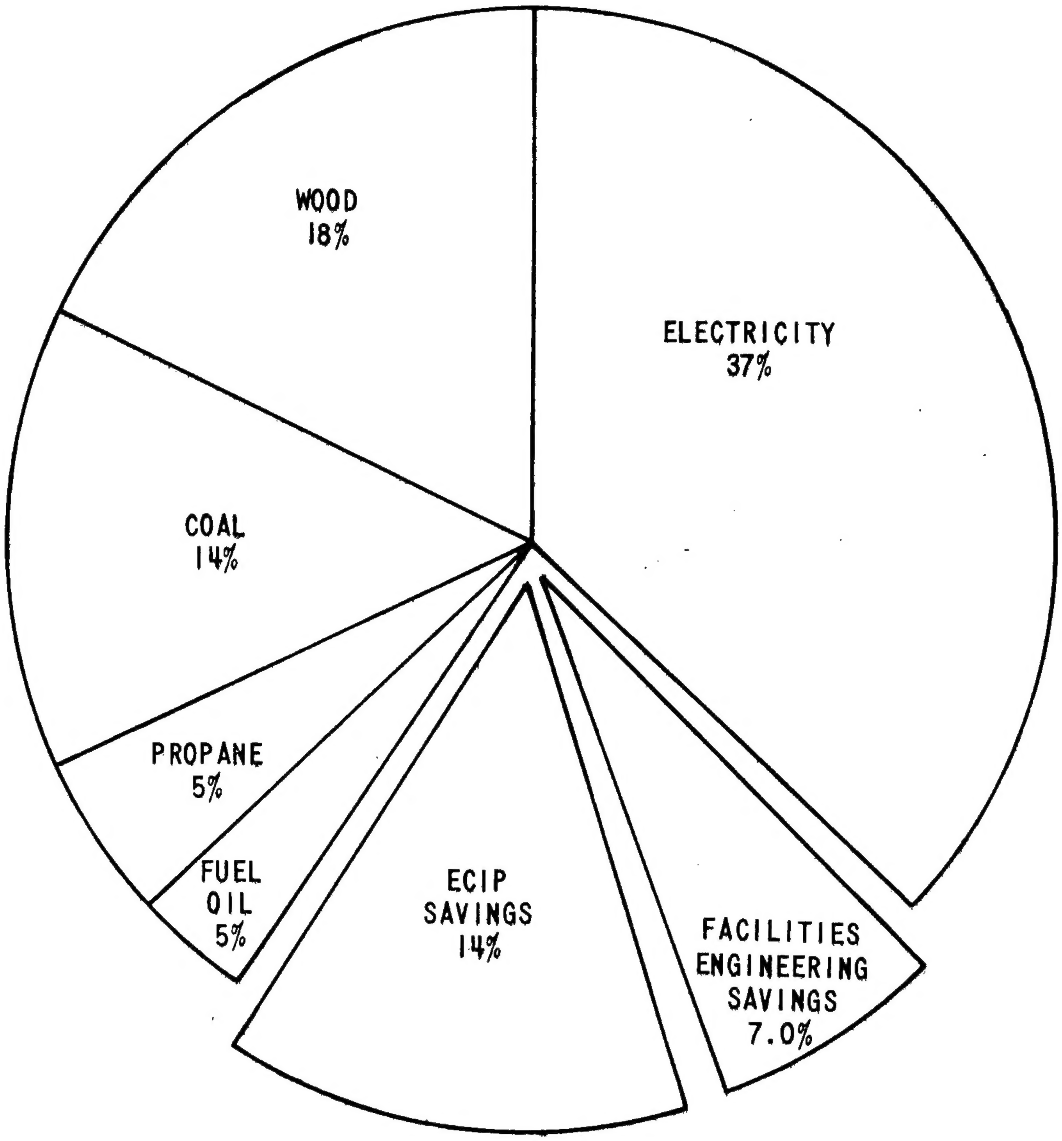


FIGURE 3

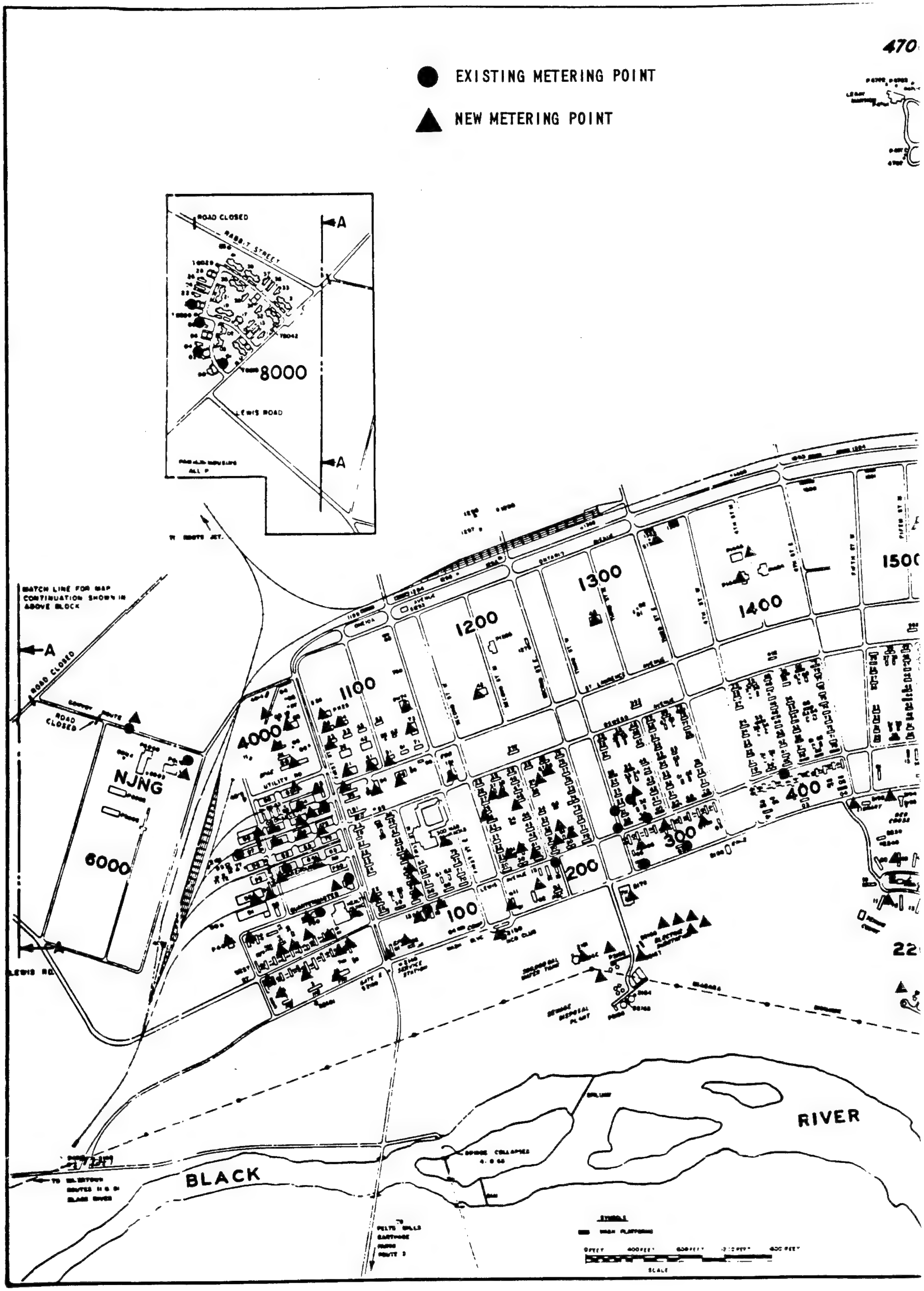
year-round. Some are occupied three months per year in the winter. Others are occupied every other January with some occupied primarily during the summer months. Tables 2, 3, 4, and 5 in Appendix A provide estimates of energy consumption for the different occupancy classes.

Those energy conservation measures which meet current ECIP criteria have been grouped into four projects. These are as follows:

ENERGY CONSERVATION INVESTMENT PROGRAM

Project Number	Title	Energy Savings Btu x 10^6	E/C	Payback (years)	Constr. Cost	FY	Index No.
T-072	Weatherization and Lighting - 300 Area	20,988	36.6	9.96	573,000	83	2808
T-073	Weatherization and Lighting - 400 Area	23,908	32.9	10.35	726,000	84	3035
T-096	FM Control System	25,573	78.2	2.00	352,000	84	3035
T-097	Weatherization and Lighting	32,258	41.5	3.10	777,000	84	3035

Revised December 21, 1981


EXISTING METERING POINT
NEW METERING POINT
ROAD CLOSED
RABBIT STREET
8000
LEWIS ROAD
A
A
WATCH LINE FOR MAP CONTINUATION SHOWN IN ABOVE BLOCK
A
ROAD CLOSED
NJNG
6000
4000
1100
1200
1300
1400
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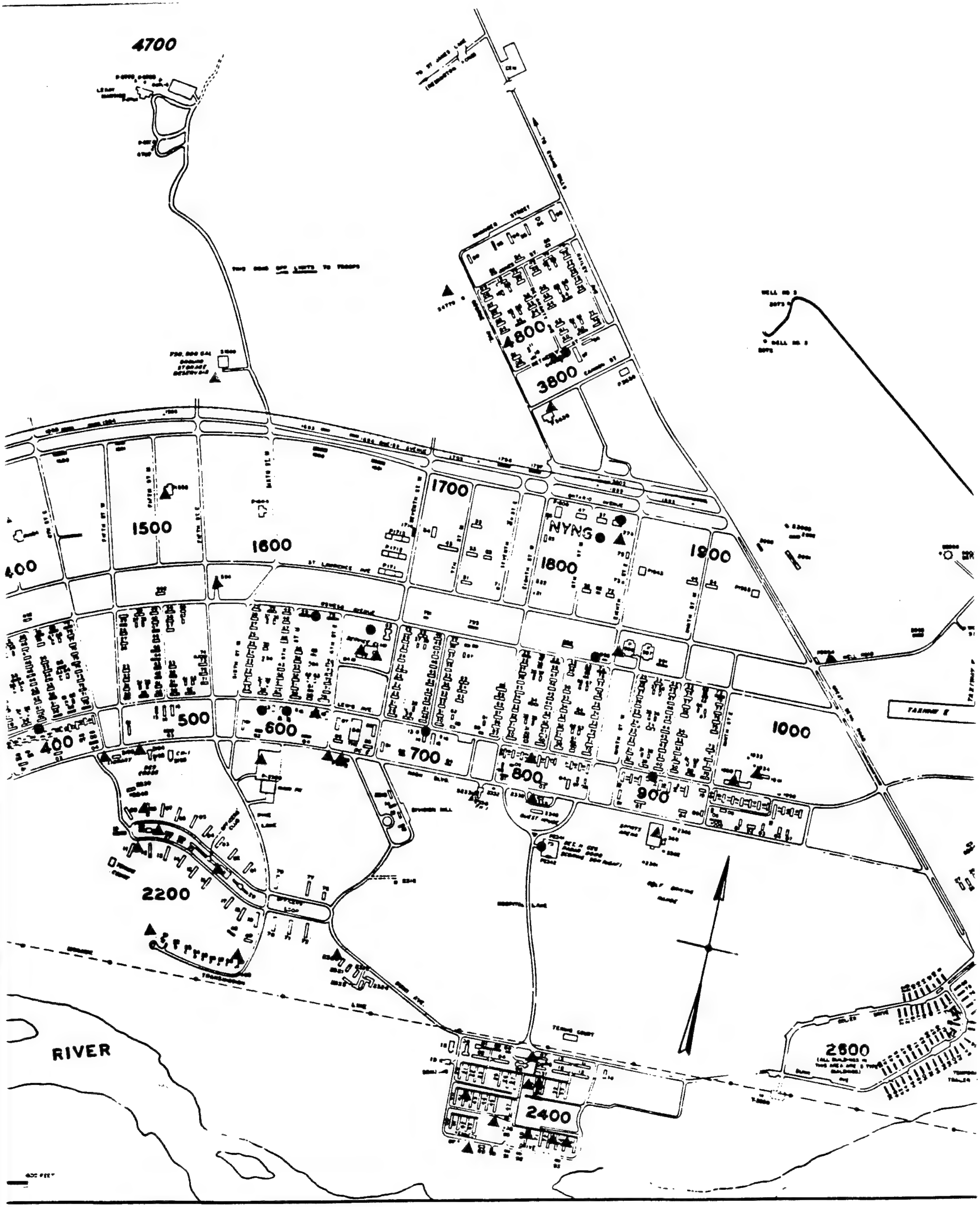
UTILITY
100
200
300
400
SEWAGE DISPOSAL PLANT
RIVER
BLACK
LEWIS RD
SYMBOLS
SCALE



4700
4800
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NYNG
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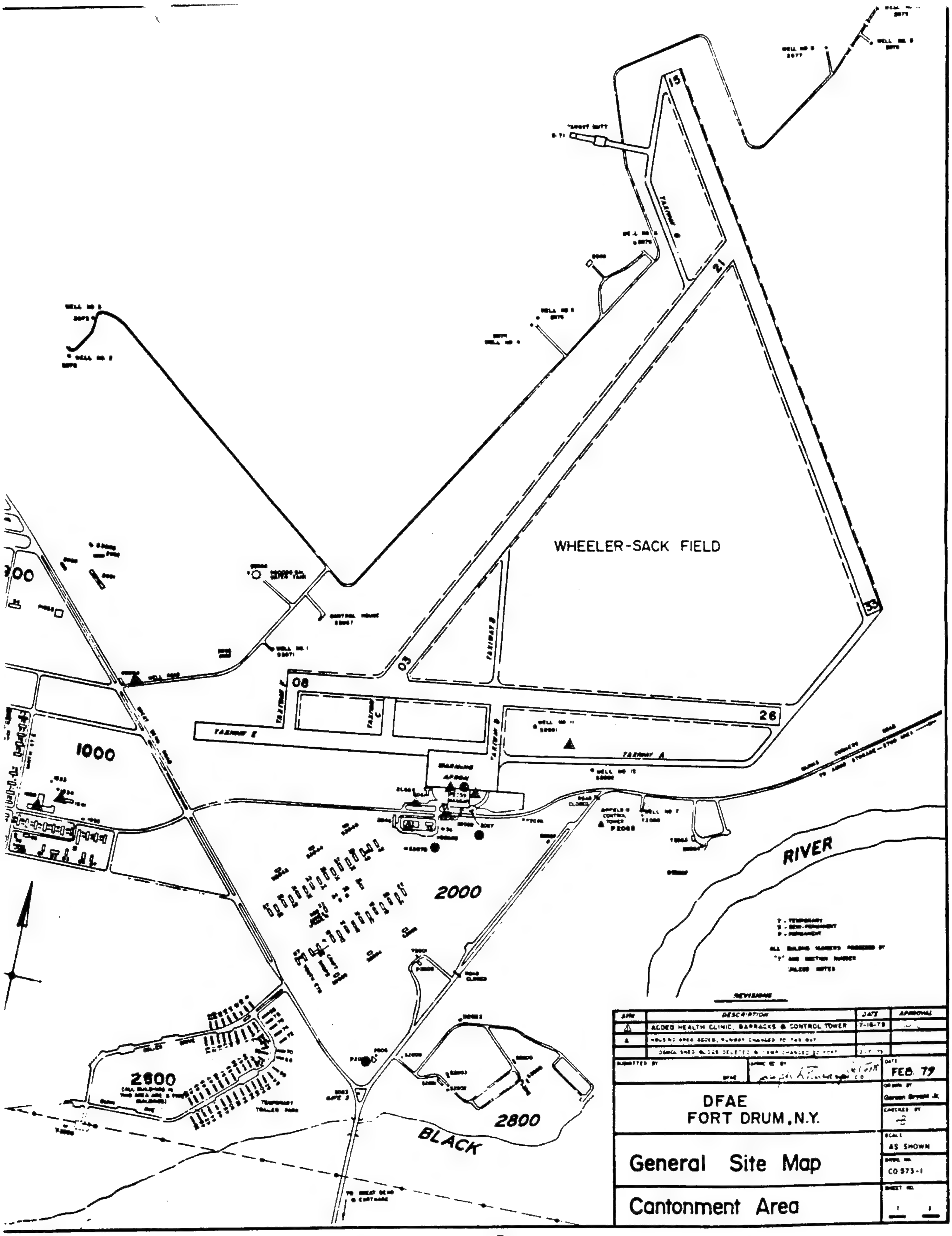
2200
RIVER
2400
2800


WHEELER-SACK FIELD
15
21
03
08
26
33
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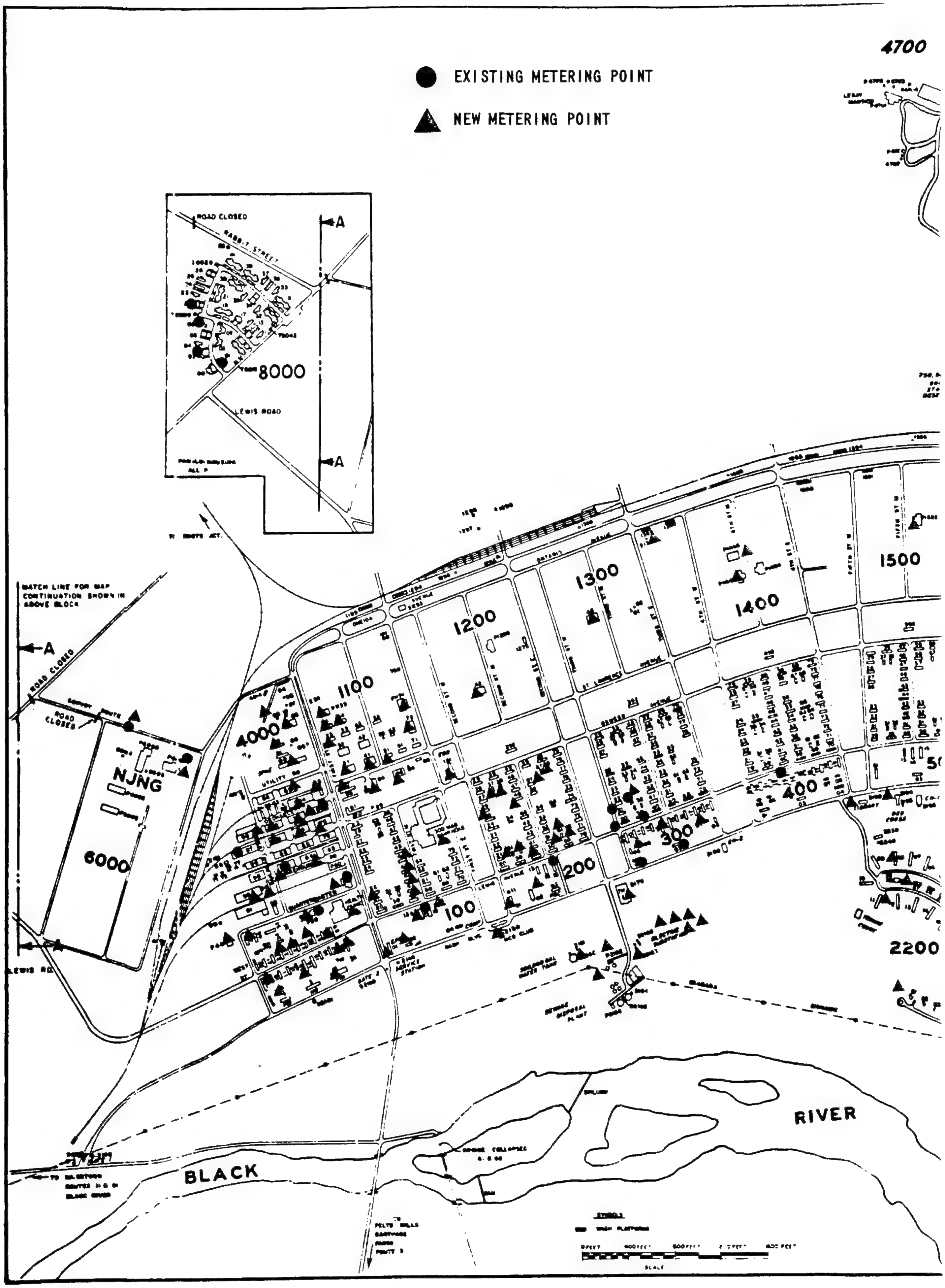
RIVER
BLACK
REVISIONS
DESCRIPTION
DATE
APPROVAL
ADDED HEALTH CLINIC, BARRACKS & CONTROL TOWER
FEB 79
DFAE
FORT DRUM, N.Y.
AS SHOWN
General Site Map
Cantonment Area


4700
EXISTING METERING POINT
NEW METERING POINT
ROAD CLOSED
LEWIS ROAD
8000
A
A
MATCH LINE FOR MAP CONTINUATION SHOWN IN ABOVE BLOCK
A
ROAD CLOSED
ROAD CLOSED
NJNG
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1100
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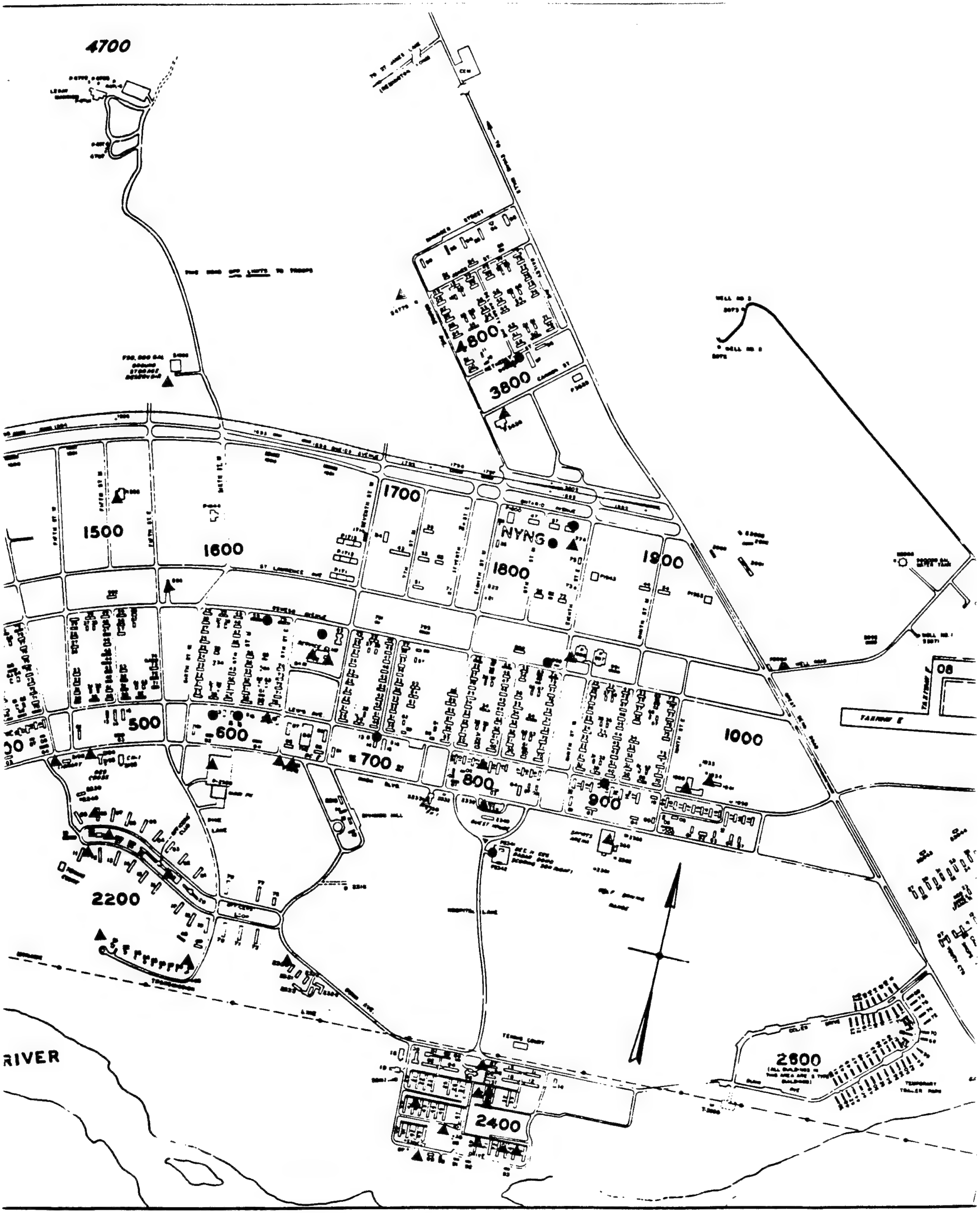
RIVER
BLACK
LEWIS RD.
SCALE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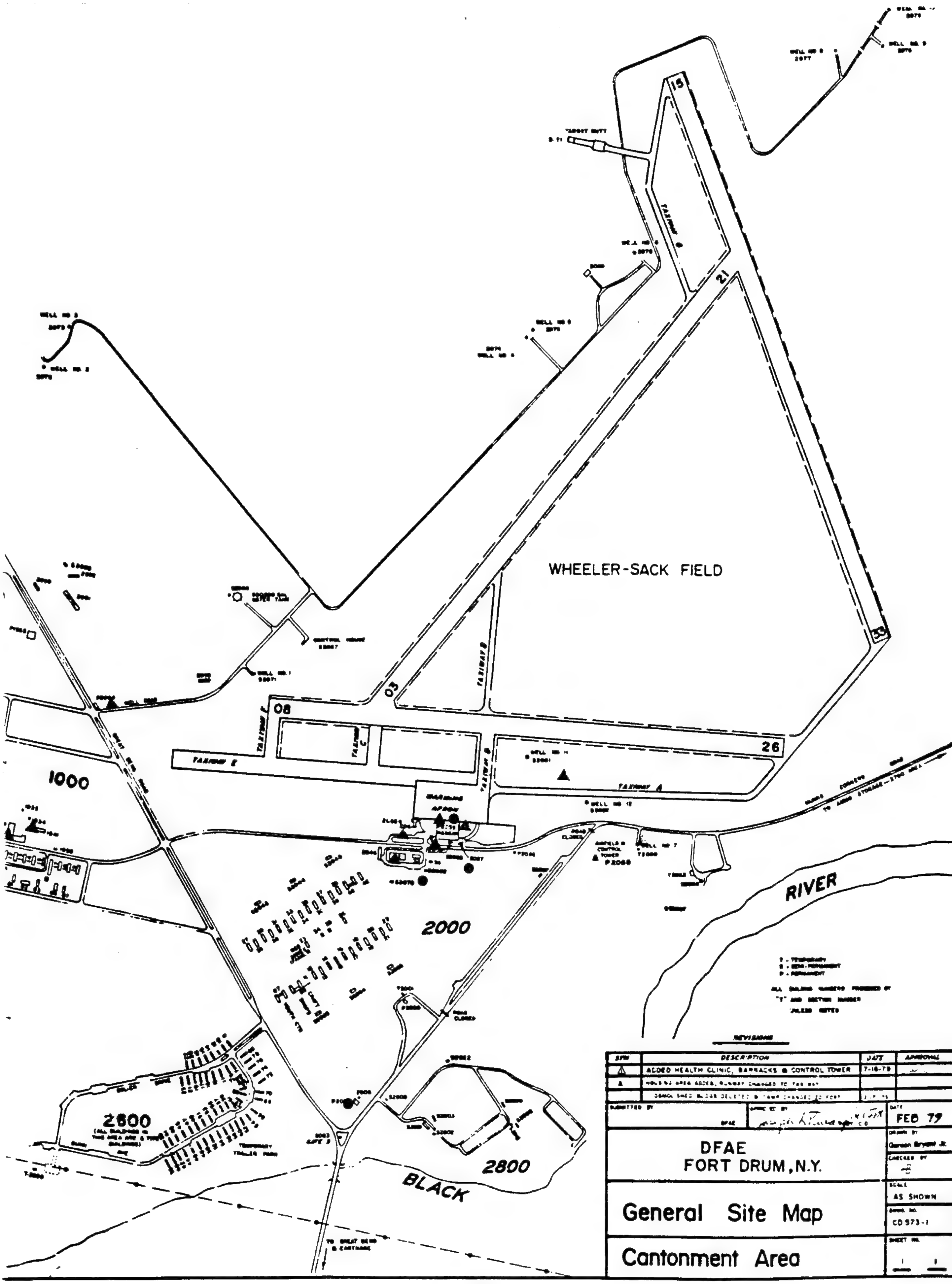
2600
RIVER
08


WHEELER-SACK FIELD
15
21
33
03
08
26
TAXIWAY A
TAXIWAY E
1000
2000
2800
2800
RIVER
BLACK
DFAE
FORT DRUM, N.Y.
General Site Map
Cantonment Area
ADDED HEALTH CLINIC, BARRACKS & CONTROL TOWER
7-16-79
FEB 79
AS SHOWN
CD 573-1

Electricity is supplied by Niagra-Mohawk Power Company. Fuel oil, propane, and coal are acquired through local suppliers.

B. HISTORICAL ENERGY CONSUMPTION DATA.

1. Utilitiy Usage. To enable the development of an energy usage model and to determine usage patterns peculiar to Fort Drum, historical energy data for fossil fuel and electricity consumption were gathered for the last three years. Fort Drum utilizes electricity, coal, fuel oil, and propane gas as energy sources. Postwide consumption data for these sources are shown on Figures 4 through 8. The graphs shown on these figures depict energy usage for calendar months; however, since utility billings do not conform to calendar months, the peaks shown on the graphs are not precise. Due to bookkeeping and inventory procedures, the graphs for fuel oil, and coal depict purchases and not consumption. The peak electrical energy consumption, 2,640,000 kWh, and the peak electrical demand, 5,190 kW, occurred in January 1978 due to the Empire Glacier winter training exercise. As shown in Figure 9, the peak fossil fuel consumption also occurred in January 1978.

Table 1 is a compilation of yearly source or raw energy consumed for FY's 1977, 1978, and 1979. The largest energy source used each year at Fort Drum is electricity, followed by fuel oil and coal. The reason that FY 1978 is markedly higher than either Fy 1977 or FY 1979 is that the Empire Glacier winter training exercise occurs every other year in even numbered fiscal years. For the month of January in Empire Glacier years, virtually all of Fort Drum is occupied.

PROPANE FUEL

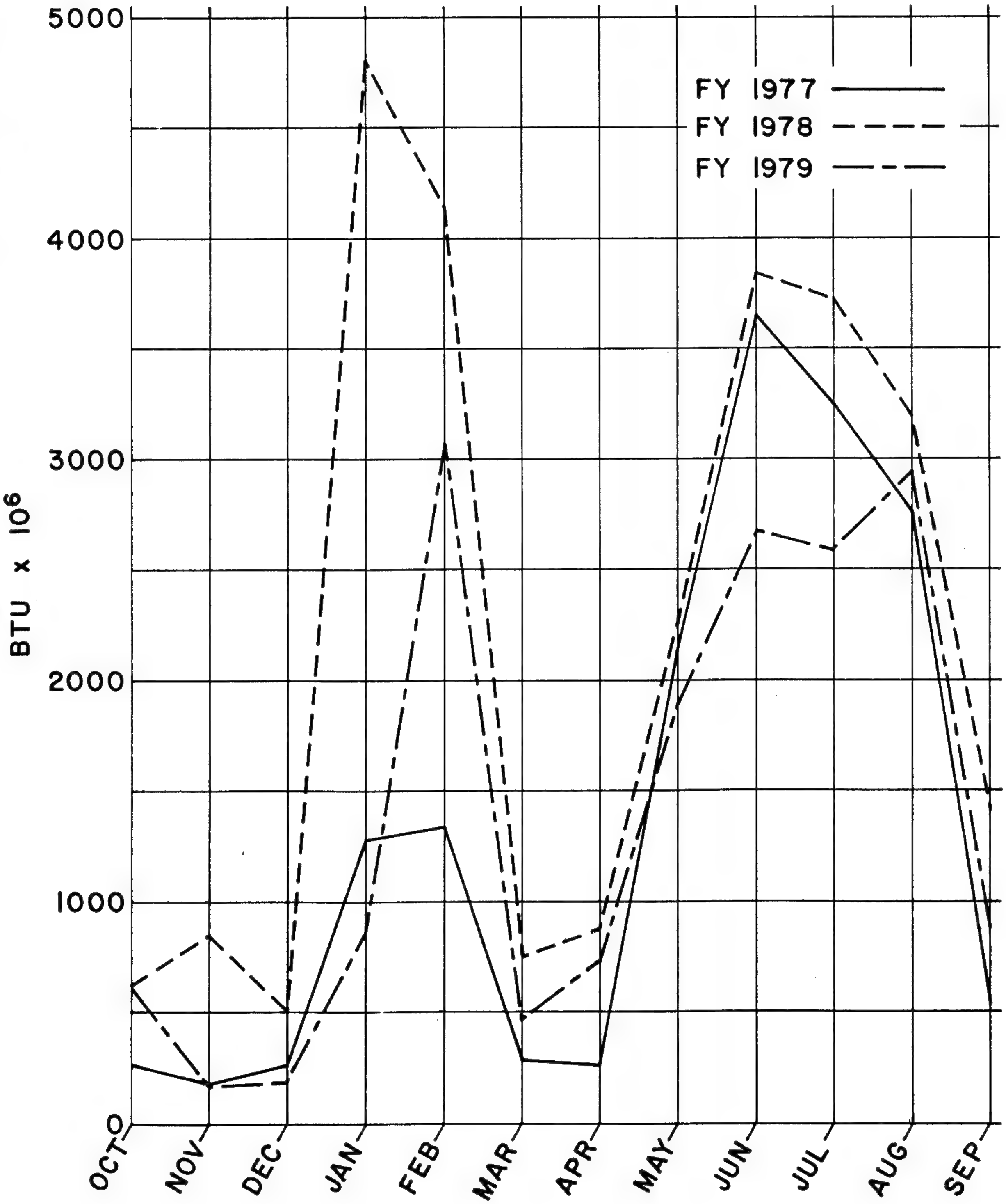


FIGURE 7

Revised December 21, 1981

TABLE 12

AIR-CONDITIONING

Location	Quantity	Individual Size (Tons)
T-34	1	8
P-36	1	40
T-55	1	10
	1	12
T-63	1	1
	1	5
T-85	2	1.5
	1	2
T-96	1	5
	1	3
T-203	3	1
T-613	2	5
T-614	3	5
T-615	3	5
T-682	4	5
	2	3
T-686	1	3
	1	1
T-688	1	1
T-701	1	1
T-702	2	8
T-1030	4	1
T-2023	2	3
P-2059	1	10
T-2150	1	10
	1	5
T-2222	2	7.5
	2	1
P-2300	2	3
	4	5
P-2312	1	12.5
T-2408	4	1
Quick Stop	1	3
STP	1	3
Sub Shop	1	3
Trailer Airport	1	3
Trailer #7	1	3
X-Ray	1	3
Total		285

Revised December 21, 1981

TABLE 14

STREET LIGHTING

Type Light	Activation	Voltage	Wattage	Total No.
Mercury Vapor	Photo cell	120 V	175 W, 250 W, 400 W, 1,000 W	286
High & Low-Pressure Sodium	Photo cell	120 V 480 V	150 W, 250 W 250 W	142
Total				428 fixtures

Note: By order of the Post Commander, approximately one-half of the fixtures of each lighting type are energized. Only major intersections, fire phones and other critical areas remain lit.

C. UTILITY PRICES. Utility rates used for ECIP calculations are as follows:

FY 79 Electrical Rates

Energy	2.50¢/kWh
Demand	$3.03/kW
Overall	3.25¢/kWh

Revised December 21, 1981

Three types of buildings have been simulated using E CUBE 75 to obtain an estimate of energy savings associated with night and weekend setback of heating systems. Building T-203, an administrative building, showed a yearly energy savings of 20 percent. Building T-239, a storehouse, showed a yearly energy savings of 23 percent and Building P-1444, a motor repair shop, showed a yearly energy savings of 23 percent. A total of 95 buildings have been included in this project. (The control switch would switch from the present thermostat to a secondary setback thermostat). These are buildings with less than 24-hour occupancy which are inhabited all winter and have heating systems that are suitable for remote control.

During FY 1979, 23 percent of the total cost of electricity to Fort Drum, or $123,500, was due to demand charges. This is not actual consumption of energy, but the rate of consumption of energy. During FY 1979, Fort Drum was charged $3.03 per kW per month. In addition, there is a minimum demand charge for 75 percent of the highest peak reached in the preceding eleven months. This is known as a 75 percent ratchet clause. During 1979, the 75 percent ratchet came into effect for seven months, from April through October. The yearly electrical peak at Fort Drum historically occurs in January or February due to electric resistance space heating. The peak established in the winter is not only paid for in the month in which it occurs, but also in seven nonwinter months, due to the ratchet clause.

In many instances, electrical peaks can be reduced without disrupting operations or causing personnel discomfort. The method of reducing electrical demand examined here is to cycle electric heat in

family housing and in the new 99-man barracks. This can be accomplished by installing 365 FM receivers in the electric heat circuits in family housing, and the three FM receivers on the electric heat coils in the makeup air units of the 99-man barracks would be controlled by an interface with the radio control switch and the contactor controlling the electric heating coil.

This system would not qualify as an ECIP project on its own because the savings is monetary, and not energy-saving. It is, however, a cost effective addition to the FM Control System and has therefore been added to the project.

A total of 1,460 kW in connected load could be controlled by the installation of 368 receivers. An E CUBE 75 simulation of one of the family housing units indicates that there would be a 47 percent diversity on the electric heating coils during the coldest hour of the winter. The demand of these electric heating units, then, at the time that Fort Drum's electrical peak is reached, would be 47 percent of 1,460 kW, or 686 kW.

Figure 10 shows the electrical demand versus the time of the day that the highest electrical peak reached at Fort Drum during the winter of 1979-80 occurred (January 24, 1980). The peak was 5,010 kW and occurred at 8:15 a.m. If half of the 686 kW could be saved by rolling heating units in and out with the FM Control System, establishing a peak of 4,667 kW, the result would be a savings for the month of January of 343 kW x \$3.03 + \$1,039 at 1979 prices. In addition, a savings of 343 kW x \$3.03 x 75 percent x 7 months + \$5,456 would result for the months of April through October. The total annual savings, escalated to 1983, would be \$11,459:

Appendix A

TABLE 1

CONSTRUCTION DATA

Bldg.	Description	Construction: Roof	Construction: Wall	Construction: Floor	Construction: Window	"U" Values: Roof	"U" Values: Wall	"U" Values: Floor	"U" Values: Wind.	Window Area: SF	Floor Area: SF	Heating: System	Heating: Fuel	Peak Trn. Load MBH	Domestic Hot Water
T-203	Administrative	Comp. Shingles	Steel on wood frame	Wood w/metal skirt	Wood w/alum. storm	.22	.21	.25	.47	408	2,284	Furnace	Oil	119.7	Electric
T-2208	Bachelor Officer's Quarters	Comp. Shingles	Steel on wood frame	Wood w/metal skirt	Wood: double hung	.22	.20	.19	.90	832	7,670	Furnace	Oil	250.6	Electric
T-271	Barracks	Comp. Shingles	Steel on wood frame	Wood w/metal skirt	Wood: double hung	.22	.21	.25	.90	580	4,720	Furnace	Coal	178.6	Oil
T-202	Chapel	Comp. Shingles	Steel on wood frame	Wood w/con. crawl	Wood: double hung	.27	.21	.25	.90	438	3,537	Boiler	Oil	185.1	Electric
T-682	Community Service	Comp. Shingles	Clapboard on frame	Wood w/wood skirt	Wood: double hung	.24	.19	.24	.90	1,332	13,726	Boiler	Oil	551.9	Oil
T-78	Exchange Facilities	Comp. Shingles	Steel on wood frame	Wood w/con. crawl	Wood w/alum. storm	.22	.22	.26	.47	56	10,491	Furnace	Oil	419.8	Electric
P-8039	Family Housing	Comp. Shingles	Clapboard on frame	Wood w/ basement	Thermopane	.05	.07	.07	.55	118	9,808	Baseboard	Elec.	80.1	Electric
T-91	Maintenance	Comp. Shingles	Wood on wood frame	Slab on grade	Steel casement	.09	.18	-	.55	2,262	22,545	Boiler	Oil	390.0	Electric
T-2425	Medical	Comp. Shingles	Wood on wood frame	Wood w/wood skirt	Wood w/ plastic	.22	.21	.25	.47	528	3,813	Furnace	Oil	196.0	Propane
T-220	Mess Hall	Comp. Shingles	Steel on wood frame	Wood w/metal skirt	Wood: double hung	.22	.21	.25	.90	281	2,360	Stove	Coal	135.4	Propane
P-1444	Motor Repair: Permanent	Metal	Steel on steel frame	Slab on grade	Metal: sliding	.09	.22	-	1.10	232	4,166	Furnace	Oil	145.5	Electric
T-1242	Motor Repair: Temporary	Metal	Steel on steel frame	Slab on grade	Steel: projected	.30	.41	-	1.32	300	7,219	Furnace	Coal	299.1	Electric
T-231	Recreation	Comp. Shingles	Steel on wood frame	Wood w/metal skirt	Wood: double hung	.22	.21	.25	.90	169	1,144	Furnace	Oil	71.0	None
T-239	Storehouse	Comp. Shingles	Steel on wood frame	Slab on grade	Wood: double hung	.39	.32	-	.90	192	2,588	Stove	Coal	129.5	None

TABLE 2

ENERGY CONSUMPTION DATA FOR YEAR-ROUND OCCUPANCY

Bldg.	Description	Annual Source Energy Cons. Btu x 10^6 Fuel	Elec.	Total	Elec. kWh/Yr.	Btu x 10^3 $Ft.^2$
T-203	Administration	724	483	1,207	42,400	528
T-2208	Bachelor Officer's Quarters	2,120	735	2,855	63,375	372
T-271	Barracks	2,084	268	2,352	23,100	498
T-202	Chapel	1,628	80	1,708	6,900	483
T-682	Community Service	4,692	1,560	6,252	134,500	456
T-78	Exchange Facilities	3,568	532	4,100	45,900	391
P-8039	Family Housing	0	1,534	1,534	132,300	156
T-91	Maintenance	3,780	2,573	6,353	221,800	282
T-2425	Medical	1,292	437	1,729	37,700	453
T-220	Mess Hall	1,693	483	2,176	41,700	922
P-1444	Motor Repair: Permanent	772	681	1,453	58,700	349
T-1242	Motor Repair: Temporary	2,231	263	2,494	22,700	346
T-231	Recreation	425	139	564	12,000	493
T-239	Storehouse	774	62	836	5,400	323

TABLE 3

ENERGY CONSUMPTION DATA FOR
JANUARY, FEBRUARY, AND MARCH OCCUPANCY

		Annual Source Energy Cons. Btu x 10^6				
Bldg.	Description	Fuel	Elec.	Total	Elec. kWh/Yr.	Btu x 10^3 Ft.^{2}
T-203	Administration	381	119	500	10,300	219
T-2208	Bachelor Officer's Quarters	1,034	181	1,215	15,600	158
T-271	Barracks	937	66	1,003	5,695	213
T-202	Chapel	826	20	846	1,800	239
T-682	Community Service	2,440	385	2,825	33,200	206
T-78	Exchange Facilities	1,831	131	1,962	11,300	187
P-8039	Family Housing	N/A	N/A	N/A	N/A	N/A
T-91	Maintenance	2,244	633	2,877	54,600	128
T-2425	Medical	664	108	772	9,300	202
T-220	Mess Hall	685	119	804	10,300	341
P-1444	Motor Repair: Permanent	449	168	617	14,500	148
T-1242	Motor Repair: Temporary	1,296	65	1,361	5,600	189
T-231	Recreation	222	34	256	3,000	224
T-239	Storehouse	448	15	463	1,300	174

TABLE 4

ENERGY CONSUMPTION DATA FOR JANUARY OCCUPANCY

Bldg.	Description	Annual Source Energy Cons. Btu x 10^6 Fuel	Elec.	Total	Elec. kWh	Btu x 10^3 Ft.^{2}
T-203	Administration	141.6	41.7	283.3	3,600	124
T-2208	Bachelor Officer's Quarters	382.5	62.8	445.3	5,400	58
T-271	Barracks	344.3	22.9	367.2	2,000	78
T-202	Chapel	305.8	7.0	312.8	600	88
T-682	Community Service	906.3	132.2	1,038.5	11,400	76
T-78	Exchange Facilities	171.1	58.7	229.8	5,100	22
P-8039	Family Housing	N/A	N/A	N/A	N/A	N/A
T-91	Maintenance	858.6	223.8	1,082.4	19,300	48
T-2425	Medical	141.6	41.7	183.0	3,600	80
T-220	Mess Hall	250.8	41.0	291.8	3,500	124
P-1444	Motor Repair: Permanent	171.1	58.7	229.8	5,100	55
T-1242	Motor Repair: Temporary	493.2	22.7	515.9	2,000	72
T-231	Recreation	82.5	11.8	94.3	1,000	82
T-239	Storehouse	170.6	5.3	175.9	500	68

TABLE 5

ENERGY CONSUMPTION DATA FOR ONE SUMMER MONTH OCCUPANCY

Bldg.	Description	Annual Source Energy Cons. Btu x 10^6 Fuel	Elec.	Total	Elec. kWh	Btu x 10^3 / $Ft.^2$
T-203	Administration	0	41.7	41.7	3,600	18
T-2208	Bachelor Officer's Quarters	24.2	62.8	87.0	5,400	11
T-271	Barracks	44.1	22.9	67.0	2,000	14
T-202	Chapel	0	7.0	7.0	600	2
T-682	Community Service	0.5	132.2	132.7	11,400	10
T-78	Exchange Facilities	0	58.7	58.7	5,100	6
P-8039	Family Housing	N/A	N/A	N/A	N/A	N/A
T-91	Maintenance	0	223.8	223.8	19,300	10
T-2425	Medical	38.3	37.1	75.4	3,200	20
T-220	Mess Hall	63.6	41.0	104.6	3,500	44
P-1444	Motor Repair: Permanent	0	58.7	58.7	5,000	14
T-1242	Motor Repair: Temporary	0	22.7	22.7	2,000	3
T-231	Recreation	0	11.8	11.8	1,000	10
T-239	Storehouse	0	5.3	5.3	500	2